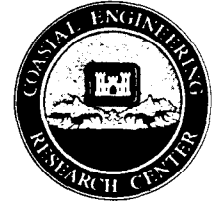


Coastal Engineering Technical Note



HELICOPTER-BORNE NEARSHORE SURVEY SYSTEM

PURPOSE: Bathymetric surveying can be difficult and hazardous near coastal structures or in regions of high surf or drastically varying topography. Using the Helicopter Borne Nearshore Survey System (HBNSS), safe and reliable measurements can be made of coastal seabeds and structure relief.

BACKGROUND: In 1960 the US Army Corps of Engineers (USACE) Portland District developed the Helicopter Borne Nearshore Survey System (HBNSS) (Craig and Team, 1985). The purpose of the system is to measure bathymetry (seabed elevations) to depths of -12 m and relief of rubble mound structures along the Pacific coast. The survey helicopter is fitted with a 26-m weighted cable graduated similar to a surveyor's rod. A shore-based surveyor's level is used to read elevations, and horizontal positioning is obtained using a shore-based electronic total distance station (TDS) aimed at a cluster of prisms mounted on the helicopter. Because of the maneuverability of the helicopter, this survey system can operate safely and accurately in most hazardous regions during severe wave events and in most weather conditions, although heavy fog or winds in excess of 50 km/hr will prevent operation of the helicopter. Bathymetric data and structure relief gathered via HBNSS have been used to compare shoreline and nearshore bathymetric change and to aid in design and documentation of structure placement and stability. A video prepared by the USACE Portland District and Craig and Team (1985) gives a detailed discussion of this system and its equipment.

DESCRIPTION: The HBNSS requires a helicopter crew, a helicopter equipped with an undercarriage-pulley system tailored for travel of the survey cable, a prism cluster, the survey cable, a land crew, a TDS, a surveyor's level, and range poles. The land crew is composed of four members: TDS operator, level reader, data recorder, and a person to assist and evaluate the angle of the cable. The survey cable consists of three parts: a weak link leader cable with a 27-kg main weight, the graduated cable, and the travel cable with a 18-kg counterweight (figure 1).

Range poles and the TDS are set up on the beach along the profile line. The helicopter supporting the cable system moves offshore to the end of the profile line (figure 2). Line of sight on the range poles and radio communication with the TDS operator help the pilot to position the helicopter at the appropriate distance offshore while remaining on line. The pilot lowers the helicopter until the main weight reaches the seabed and the cable tension goes slack. The level operator continuously views the graduated portion of cable through the level as the cable is lowered. At the instant the cable goes slack the level operator reads the elevation to the nearest tenth of a foot and relays this information to the data recorder. At the same time, the TDS operator has the TDS aimed at the prism cluster mounted on the helicopter and takes a reading of the horizontal location of the helicopter, thus providing the information to the data recorder. After the location and depth have been hand recorded, the pilot, notified by radio, then raises the helicopter so that the weight clears the water surface and moves forward on the range line toward the beach to the next point, where the process is repeated. The distance between points is determined by density requirements of the survey. Each point requires 5 to 10 seconds to read instruments and record data. The greater portion of the time is spent maneuvering the helicopter between points. Approximately 50 to 60 points can be surveyed along a 900 to 1600 m long profile line in 20 minutes. Time between lines range from the few minutes necessary to reposition the helicopter to the time required to move the TDS and level to a new position, if needed.

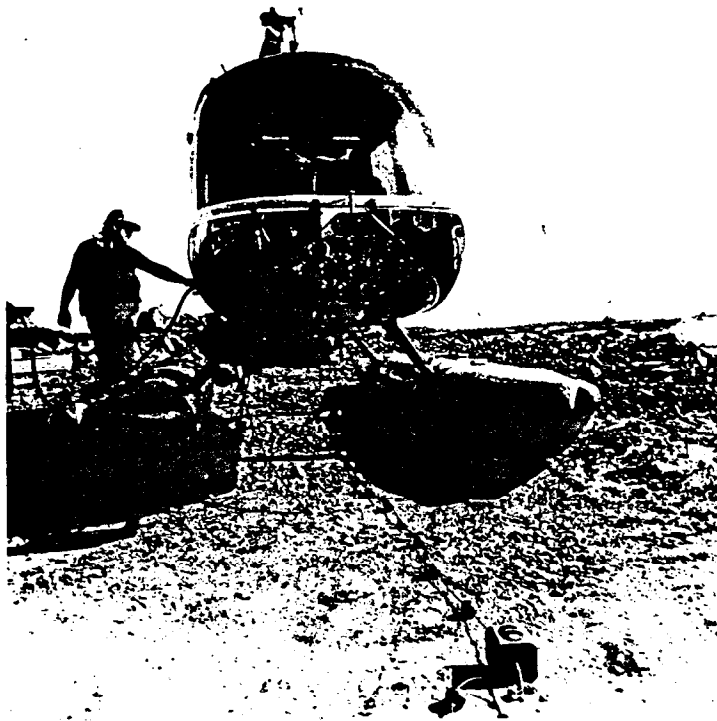


Figure 1. Helicopter, undercarriage, and survey cable

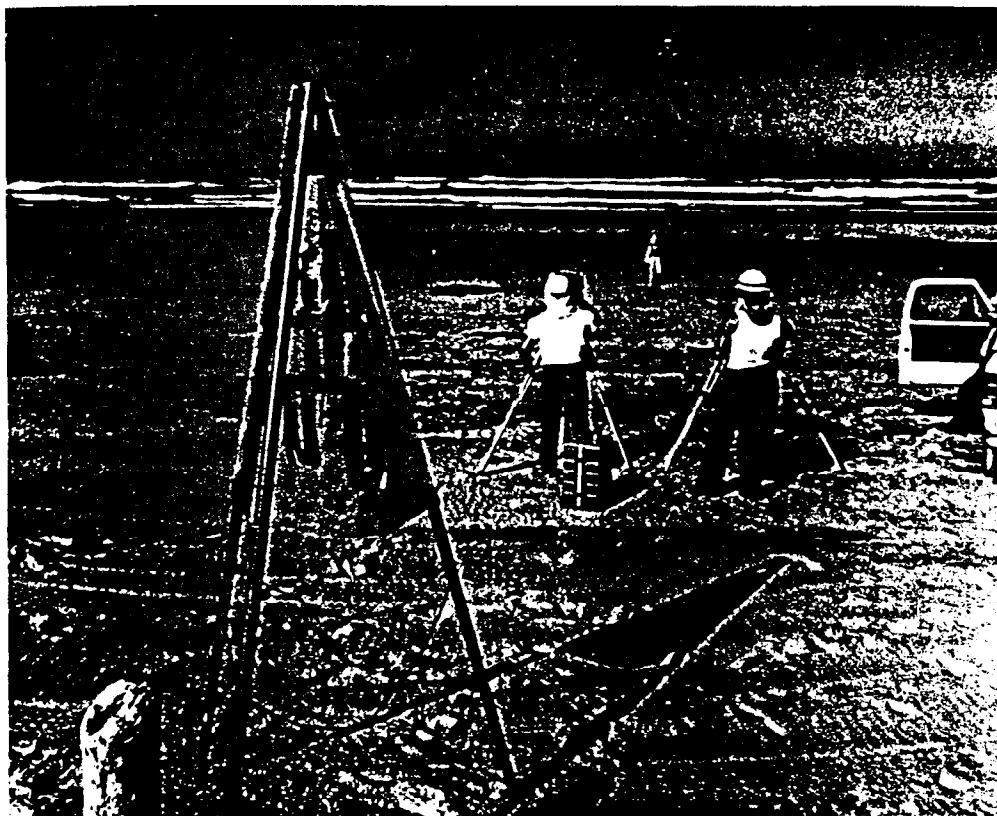


Figure 2. Helicopter, range poles, and total station on profile line.

ACCURACY AND REPEATABILITY: In July 1990, a field study evaluated the HBNSS for accuracy and repeatability, under the Monitoring of Completed Coastal Projects Program's Siuslaw River workunit. The Coastal Engineering Research Center's Field Research Facility CRAB survey system was used as a control. A detailed discussion of the CRAB system (including its accuracy and reliability) is presented in Birkemeier and Mason (1984). Additionally, Clausner, Birkemeier, and Clark (1986) present a similar field comparison of the CRAB with other nearshore survey systems. In the previous comparison study, a Zeiss Elta-2 TDS provided the horizontal and vertical position of the CRAB. During the July 1990 study, a Geodimeter 140T self tracking TDS replaced the Zeiss. The Geodimeter 140T increases the number of points that can be reasonably collected along a line, yielding an almost continuous profile. This increased the quality of the CRAB survey and the likelihood that positions of soundings taken using the HBNSS would closely coincide with CRAB soundings.

The July 1990 field test was designed to evaluate the HBNSS ability to survey a known profile cross section, stay on line, and produce repeatable results. Test day conditions were characterized by small, long-period waves and moderate to low longshore currents. Repeatability tests included five repetitive surveys on two cross sections of diverse topography. For these tests, the reference profile shape was determined by two repetitive surveys by the CRAB. Therefore, accuracies are relative to the accuracy of the CRAB. Figures 3 and 4 show the envelope of four HBNSS surveys superimposed over one CRAB survey for test profile lines 100 and 200 respectively. The upper portion of the figures graphs the envelope of the maximum vertical deviation and standard deviation along the profile of all four HBNSS measured profiles from the CRAB measured profile. These figures indicate that HBNSS provides accurate and repeatable measurement of the true profile shape. The absolute maximum vertical deviation is 0.6 m and 1.0 m, the mean vertical deviation is 0.1 m and 0.07 m, and the respective mean standard deviations are 0.06 m and 0.05 m for profiles 100 and 200 respectively. The larger deviations occur where points were missed over the bars and can be eliminated by increasing the density of sampling. Tests of vertical accuracy differences between a fathometer survey and a CRAB survey conducted by Clausner, Birkemeier, and Clark (1986) indicate maximum deviations of the fathometer to be 0.67 m and mean vertical deviation to be 0.25 m greater than 300 m offshore.

Figure 5 shows the distance off line of the CRAB and four helicopter surveys for profile cross section line 100. For the most part, the helicopter remained within 6 m of the profile line and the CRAB within 3 m of the line. Greater deviation from the line for both the CRAB and the helicopter occurred farther offshore. The large deviation in the one helicopter survey reflects communication problems between the pilot and land crew.

POSSIBLE AUTOMATION IMPROVEMENTS: Coupling the TDS with a data logging computer would allow the horizontal positions to be recorded automatically. The level would still be used to read elevations, but these values could be directly entered into the computer as they are taken. A step further in automating HBNSS would be to attach a ring of prisms on the cable and use a tracking TDS such as the Geodimeter 140T linked to a data logger. At the instant the cable weight reaches the seabed, the TDS operator marks the data point. Horizontal positioning and depths would automatically be entered into the data file. Marked data points would compose the profile. This process could reduce the land crew to one member. For both automation methods, a complete digital record (ASCII file) would be available at the end of each profile and circumvent the need to digitize hand recorded field data, thus reducing potential error. Additionally, the TDS and level would not need to be moved from profile to profile if the lines are within instrument ranges.

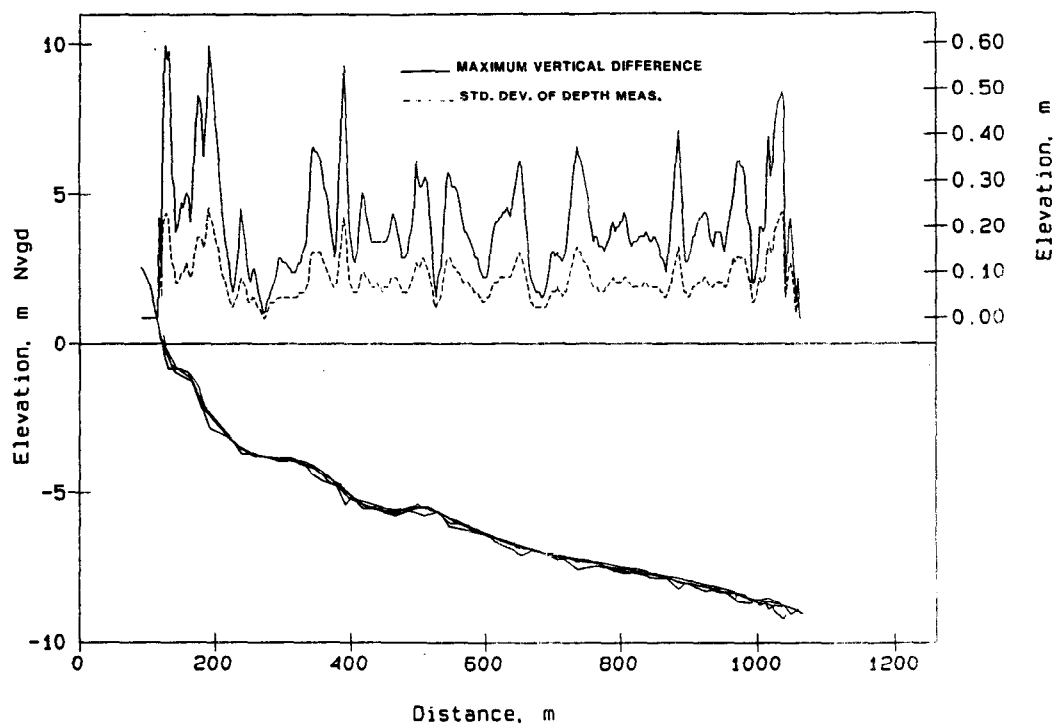


Figure 3. CRAB survey and four HBNSS surveys of line 100.

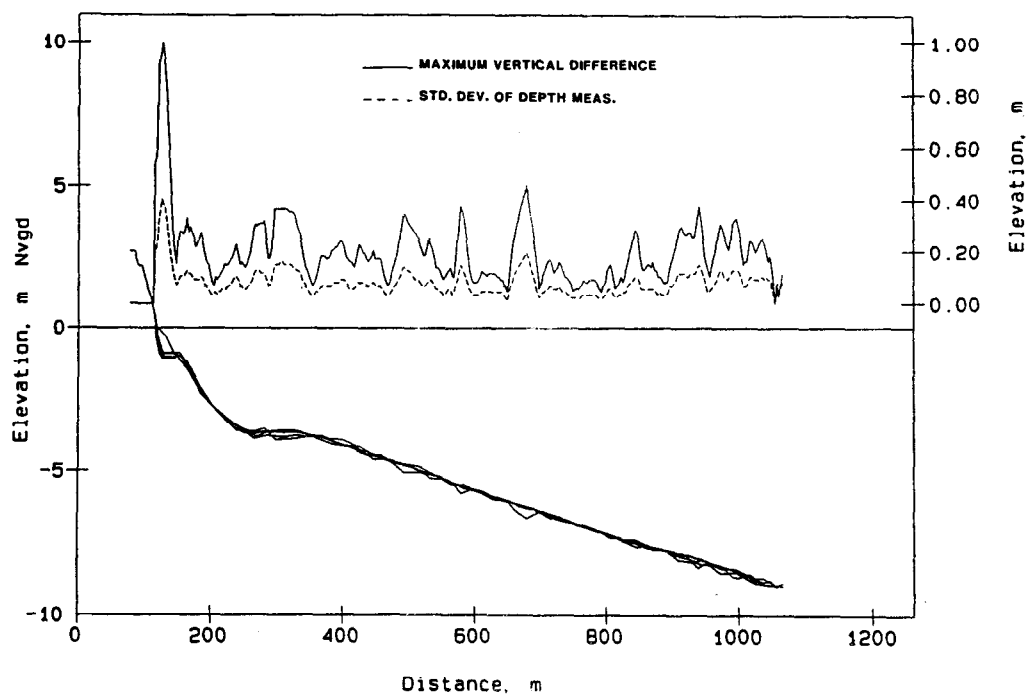


Figure 4. CRAB survey and four HBNSS surveys of line 200.

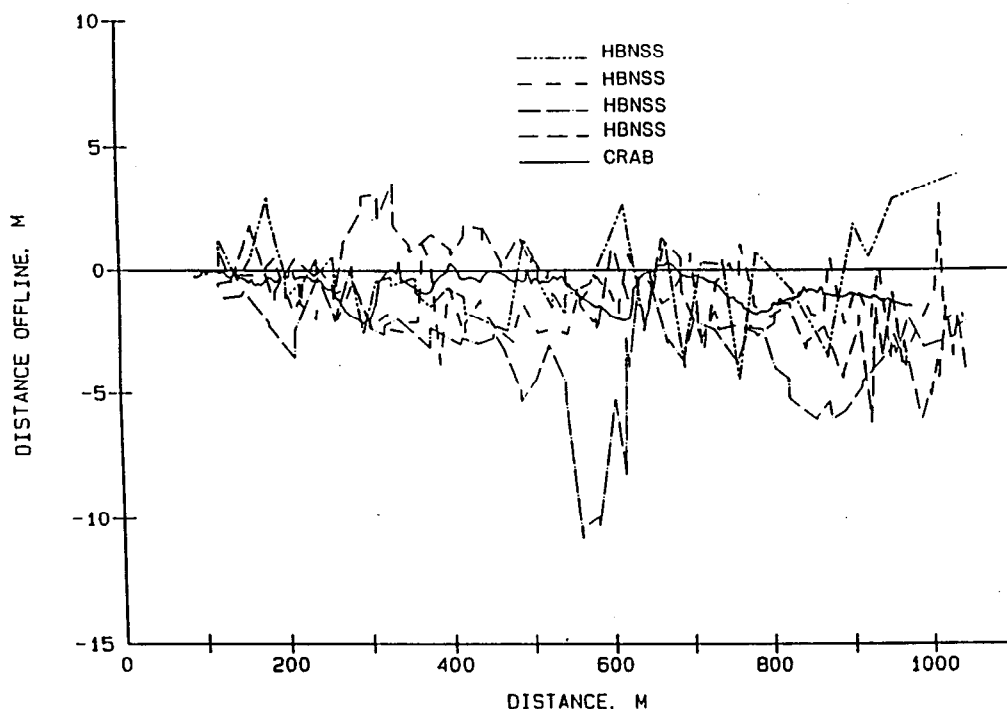


Figure 5. Distance off line of CRAB and four HBNSS surveys.

SUMMARY: The Helicopter-Borne Nearshore Survey System can be used to measure seabed and structure topography in hazardous regions where other survey vessels can not operate safely. Soundings can be taken quickly and are accurate and repeatable.

ADDITIONAL INFORMATION: For further information, contact Ms. Cheryl Burke Pollock, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Engineering Development Division, Coastal Structures Branch, at (601) 634-4029.

REFERENCES:

Birkemeier, W.A. and Mason, C. 1984. "The CRAB: A Unique Nearshore Surveying Vehicle," Journal of Surveying Engineering, Vol 110, No. 1, pp 1-7.

Clausner, J.E., Birkemeier, W.A., and Clark, G.E. 1986. "Field Comparison of Four Nearshore Survey Systems," CERC Miscellaneous Paper No. 86-6, US Army Engineers Waterways Experiment Station, Vicksburg, MS.

Craig, R. and Team, W. 1985. "Surf Zone and Nearshore Surveying With Helicopter and a Total Station," Proceedings of US Army Corps of Engineers Surveying Conference, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

USACE Portland District, 1985. "Video - Helicopter System"